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(71) Applicant *(for all designated States except US)*: **S.P.A. EGIDIO GALBANI** [IT/IT]; Via Togliatti, 8, I-20066 Melzo (IT).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **KREILINGER, Clemens** [DE/IT]; c/o S.p.A. Egidio Galbani, Via Togliatti, 8, I-20066 Melzo (IT).

(74) Agents: **LONG, Giorgio** et al.; Jacobacci & Partners S.p.A., Via Senato 8, I-20121 Milano (IT).

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(54) Title: PROCESS FOR PASTEURIZING CHEESE PRODUCTS, AND CHEESE PRODUCTS FORMED THEREBY

(57) Abstract: The present invention relates to a process for pasteurizing dairy products which uses the high hydrostatic pressure method. More particularly, the present invention relates to a process for pasteurizing dairy products, comprising the following stages of operation: a) placing the dairy product, as such or packaged in a suitable packaging, in the compression chamber of a machine for high hydrostatic pressure treatment, the chamber being filled with incompressible fluid, and then sealing the compression chamber, b) raising the pressure within the said compression chamber for a period of approximately 1-10 minutes, until a pressure in the range from 4000 bars to 6000 bars is reached, c) maintaining the pressure within the said compression chamber for a period of approximately 2-10 minutes at a temperature in the range from 0°C to 25°C, d) decompressing to atmospheric pressure, opening the compression chamber and removing the said dairy product. The dairy product made in this way has improved characteristics by comparison with the identical untreated product; in particular, it is more digestible and has better keeping quality.

microwaves has been proposed, as has the use of high hydrostatic pressure. The application of high pressure induces morphological changes in the cells of microorganisms, which may be sufficient to rupture the cell membrane and thus cause the death of the microorganisms. The efficiency and quality of the pasteurization achieved by a high pressure treatment depend on various factors, including the level of pressure and the temperature to which the food is subjected, the processing time, and the type of pressure/decompression cycle used, if applicable.

It should be noted in this connection that, owing to the adiabatic compression of the fluid in which the product to be pasteurized under high pressure is immersed, the fluid temperature will tend to increase by 4°C for every 1000 bars of pressure. Consequently, if pressures in excess of 4000-5000 bars are applied, the temperature in the compression chamber may rise by 16-20°C or more above the initial level. Thus this factor may also have a drastic effect on the outcome of the process. Indeed, although on the one hand a rise in temperature can accelerate pasteurization and thus shorten the treatment time, on the other hand the high temperature may cause a degradation of the quality of the product.

It is evident from the above that the selection of an appropriate pasteurization process for a food product is an operation which generally requires a considerable number of trials, for the purpose of identifying the optimal conditions in which the food reaches the requisite degree of pasteurization without any changes in its qualitative properties.

This is particularly the case where the food product to be treated is a dairy product, particularly a cheese. It is known that a considerable part of the aroma and flavour of many cheeses is determined by the presence of microorganisms such as moulds and the like. Examples of such cheeses are Gorgonzola and Roquefort, in which the blue veins are due to the presence of *Penicillium Roqueforti*, Brie (*Geotricum Candidum*) and Camembert (*Penicillium Camemberti*). However, many other cheeses, such as Taleggio, also have their most characteristic element in their rinds, in which specific microorganisms are developed during the maturing process.

Clearly, a process of pasteurizing cheese, which is desirable if the requisite hygiene is to be provided for the consumer, must, as far as possible, keep alive the microorganisms responsible for the essential sensory characteristics of the cheese.

Accordingly, the problem which the present invention is intended to resolve is that of providing a process for pasteurizing cheese products which meets the above requirements, in other words one which maintains an ideal balance between the hygiene of a product and the preservation of its sensory and nutritional characteristics.

This problem is resolved by a process as outlined in the attached claims.

In the method according to the present invention, the cheese product is treated at a pressure in the range from 5000 to 6000 bars and at an initial temperature in the range from 0°C to 25°C, preferably from 3°C to 15°C. More preferably, the cheese is treated at a pressure of approximately 6000 bars and a temperature of approximately 4°C.

The high pressure treatment is continued for a period ranging from 2 minutes to 10 minutes, depending on the pressure and temperature applied. In the case of the preferred conditions of pressure (6000 bars) and temperature described above, an optimal treatment time is 2-4 minutes.

The process according to the present invention comprises the following stages of operation:

a) placing the cheese product, in its existing

state or packaged in a suitable packaging, in the partially fluid-filled compression chamber of a machine for high hydrostatic pressure treatment, completing the filling (eliminating any voids) with the same fluid, and then sealing the compression chamber,

b) raising the pressure within the said compression chamber for a period in the range from 1 to 10 minutes, preferably 2-4 minutes, until a pressure in the range from 4000 bars to 6000 bars is reached,

c) maintaining the pressure within the said compression chamber for a period of approximately 2-10 minutes, preferably 2-4 minutes, at a filling fluid temperature in the range from 3°C to 25°C,

d) decompressing to atmospheric pressure, opening the compression chamber and removing the said cheese product.

To ensure that the desired temperature indicated for stage c) is reached during the compression stage, the compression chamber, the filling fluid and the product must initially be maintained by thermostatic means at an operating temperature in the range from 0°C to 25°C, which will be determined according to the planned final temperature and the pressure at which the treatment will be carried out. For example, in the case of pasteurization carried out at 6000 bars and 4°C, the

compression chamber, the filling fluid and the product will be maintained by thermostatic means at 4°C.

A suitable machine for carrying out the process according to the present invention is the QFP 351-600 autoclave marketed by Flow Italia s.r.l.

The cheese product to be subjected to the pasteurization treatment is preferably packaged in film or in plastic trays. A preferred packaging material is selected from the group comprising polyethylene, polyethylene terephthalate, and polystyrene, used individually or in multi-layer form. A multi-layer foil of plastic material can also comprise a sheet of aluminium. Particularly suitable plastic materials are coextruded multi-layer polyolefin heat-shrink materials, preferably the Cryovac® plastic material made by Sealed Air Corp.

The packaging is preferably of the vacuum type. A vacuum of the type normally used in the packaging of food products requiring it will generally be sufficient. This is because it has been found that some cheese products, in particular, are highly sensitive to a rise in temperature, tending to melt rapidly. Typical examples of such products are cream cheeses such a Mascarpone or products containing such cheeses such as the known Gorgonzola-Mascarpone combination. Since air

is a compressible fluid, it tends to heat up considerably in the treatment conditions required by the present process, thus raising the temperature well above the softening or melting point of the cheese product.

It should be noted that the use of heat-shrink materials such as Cryovac® allows the material to adhere fully to the product, thus essentially minimizing the voids present between the product and the packaging.

The process according to the invention can be applied advantageously to all types of cheese product. A preferred cheese product will be a product containing a cream cheese or a combination of this with other types, for example with a blue-veined cheese.

By way of example, the process according to the invention was carried out on a composite layered cheese product specimen consisting of a combination of Gorgonzola and Mascarpone (Magor, made by Galbani). The product was vacuum-packaged in Cryovac® BB 755 food-grade plastic material.

The process was carried out as described above, the pressure being raised to approximately 6000 bars over a period of 2-10 minutes (depending on the specimens), this pressure being maintained for approximately 2 minutes. The initial temperature was approximately 4°C, and the temperature rose as a result of adiabatic

heating to approximately 32°C.

The product specimens treated in this way were then subjected, immediately after treatment or after storage for 30 or 60 days, to a series of experimental tests designed to determine their keeping quality and to discover any modifications caused by the high pressure treatment.

Each specimen was dispersed in a phosphate buffer solution at pH 6.8 and was subjected to a test of susceptibility to proteolytic action in the presence of the enzyme pancreatin, to simulate the process of in vivo digestion of the product. After 16 hours of vigorous stirring at 37°, the degree of proteolysis was determined by measuring the absorbance at 280 nm in the supernatant phase formed by precipitation with 10% trichloroacetic acid. The experiment was conducted both on a specimen treated by the process according to the invention (specimen B) and on an untreated specimen of Magor (specimen A). The results are shown in Table I.

Table I

specimen	Change in absorbance (280 nm) after incubation with pancreatin
A	0.010
B	2.785*

* Determination based on 5x diluted specimen

Specimen B (treated at high hydrostatic pressure) shows a markedly greater susceptibility to proteolytic action. This indicates that the high pressure treated product is more digestible than the untreated product.

Further product specimens treated according to the process of the invention were subjected to determination of the soluble proteins. Some specimens were analysed immediately after their preparation and the high pressure treatment, while other specimens were stored for 30 days and for 60 days. In this case also, the products treated by the process according to the invention (specimens B) were compared with untreated products (specimens A). Before the determination, the product specimens were dispersed in a phosphate buffer solution at pH 6.8 and the dispersion was then centrifuged to eliminate the lipid fraction (the protein fraction remained in solution). The suspension formed in this way was then acidified to pH 4.6 by the addition of 10% v/v acetic acid and the insoluble proteins were removed by centrifuging (10,000 r.p.m. for 15 minutes at 2°C). The supernatant phase was concentrated by ultrafiltration with a nominal cut-off of 5000 daltons up to a factor of 20.

The protein content of the specimens was determined

by the Bradford colorimetric method (a spectrophotometric method based on the colorimetric complex formed between hydrophobic residues of a protein and Coomassie Blue G-250 dye). The protein concentration was expressed with reference to a calibration straight line obtained by using bovine serum albumin as a marker protein. The results of the determinations are shown in Table II.

Table II

Specimen	Soluble protein fraction, mg/g of original material					
	Start of storage		30 days		60 days	
	Phosphate	Urea, DTT	Phosphate	urea, DTT	phosphate	urea, DTT
A	18.9	32.5	2.4	3.3	1.5	1.9
B	10.9	19.6	6.1	8.8	2.3	3.4

The experimental data show that there is a marked decrease (approximately 90%) of soluble proteins after only 30 days' storage in specimen A (untreated). In specimen B (high pressure treated), the decrease in soluble proteins after 30 days of storage is approximately 50%.

This shows that specimen B, treated by the process according to the invention, shows fewer changes in protein content due to storage. This indicates that the product treated by the process according to the invention has better keeping qualities than the untreated product.

The process according to the present invention enables a degree of pasteurization of a cheese product to be achieved in accordance with the necessary requirements of hygiene, without essentially

compromising the content of characteristic microorganisms such as moulds, which contribute to the typical flavour of many cheeses. The experiments which were conducted demonstrated that, at higher pressures and temperatures than those used in the present process, the content of beneficial microorganisms in the cheese was reduced to unacceptable levels, such that the sensory and nutritional properties of the cheese were irreversibly altered. Conversely, more moderate pressure and temperature conditions did not provide sufficient hygiene of the food.

The inventors of the present invention have also surprisingly discovered that, as shown by the experimental data discussed above, the treatment of cheese products at high hydrostatic pressure imparts particularly advantageous properties to these products. In particular, the cheese products that can be formed by means of the high hydrostatic pressure process described herein are characterized by improved digestibility and keeping qualities by comparison with the identical untreated product.

Clearly, a person skilled in the art will be able to adapt the process described above to meet particular requirements, without thereby departing from the scope of the present invention as defined in the attached

claims.

CLAIMS

1. Process for pasteurizing dairy products, comprising the following stages of operation:

a) placing the dairy product, as such or packaged in a suitable packaging, in the fluid-filled compression chamber of a machine for high hydrostatic pressure treatment, and then sealing the compression chamber,

b) raising the pressure within the said compression chamber for a period of approximately 1-10 minutes, until a pressure in the range from 4000 bars to 6000 bars is reached,

c) maintaining the pressure within the said compression chamber for a period of approximately 2-10 minutes at a temperature in the range from 0°C to 25°C,

d) decompressing to atmospheric pressure, opening the compression chamber and removing the said dairy product.

2. Process according to Claim 1, in which the said pressure is approximately 6000 bars.

3. Process according to Claim 1 or 2, in which the said temperature in stage c) is 4°C.

4. Process according to any one of Claims 1 to 3, in which the said compression stage c) is continued for 2-4 minutes.

5. Process according to any one of Claims 1 to 4,

in which the initial temperature to which the said dairy product and the said compression chamber are subject is in the range from 0°C to 25°C.

6. Process according to any one of Claims 1 to 5, in which the said dairy product is prepackaged.

7. Process according to Claim 6, in which the said packaging comprises films or trays of plastic material.

8. Process according to Claim 7, in which the said plastic material is selected from the group comprising polyethylene, polyethylene terephthalate and polystyrene, alone or in multi-layer combinations, possibly comprising a sheet of aluminium.

9. Process according to any one of Claims 1 to 8, in which the said dairy product is vacuum-packaged.

10. Process according to any one of Claims 6 to 9, in which the said dairy product is packaged in films or trays of plastic material and in which the said plastic material is a coextruded multi-layer heat-shrink polyolefin.

11. Process according to Claim 10, in which the said coextruded multi-layer polyolefin heat-shrink material is Cryovac®, made by the Sealed Air Corporation.

12. Dairy product which can be made by the process outlined in any one of Claims 1 to 11.

13. Dairy product according to Claim 12, in which the said dairy product has a greater digestibility and better keeping quality than those of the identical untreated cheese product, the said digestibility being determined by measuring the change in absorbance at 280 nm after incubation of the product with pancreatin, and the said keeping quality being determined by measuring the change in the soluble protein content of the product over time by the Bradford colorimetric method.

14. Dairy product according to Claim 12 or 13, in which the said dairy product is a composite product comprising a combination of a cream cheese and a blue-veined cheese.

15. Dairy product according to Claim 14, in which the said dairy product is a composite product comprising a combination of Mascarpone and Gorgonzola.